

DOCUMENT RESUME

ED 074 774

EM 010 973

AUTHOR Jordan, Stephen
TITLE Physiological Indices of a Simple Cognitive Task.
INSTITUTION Naval Training Equipment Center, Orlando, Fla.
REPORT NO NAVTRAEQUIPCEN-TN-8
PUB DATE Feb 73
NOTE 17p.

EDRS PRICE MF-\$0.65 HC-\$3.29
DESCRIPTORS *Cognitive Measurement; *Cognitive Tests; Measurement
Instruments; Performance Criteria; *Psychophysiology;
*Recall (Psychological); *Retention

ABSTRACT

A study attempted to determine the usefulness of skin resistance and other physiological measures as indicators of a simple cognitive skill such as the immediate recall of digits. Subjects were placed in a sound attenuated chamber and wired for heart rate and skin resistance recordings. The task involved immediate recall of a 10 alternative digit sequence and a two digit alternative sequence. Results indicated no statistically significant relationship between physiological measures of alertness (skin conductance and heart rate) and a simple cognitive task (digit recall). Further experimentation is required to resolve ambiguity of results; in particular, a design is needed in which task difficulty and task duration are systematically varied over several points over a wide range.
(Author)

FILMED FROM BEST AVAILABLE COPY

Technical Note: NAVTRAEQUIPCEN TN-8



PSYCHOLOGICAL INDICES OF A SIMPLE COGNITIVE TASK

Stephen Jordan
Human Factors Laboratory
Naval Training Equipment Center
Orlando, Florida 32813
NAVTRAEQUIPCEN Task No. 7885-23

February 1973

DoD Distribution Statement

Approved for public release;
distribution is unlimited.

NAVAL TRAINING EQUIPMENT CENTER
ORLANDO, FLORIDA 32813

FILMED FROM BEST AVAILABLE COPY

Technical Note: NAVTRAEQUIPCEN TN-8

PHYSIOLOGICAL INDICES OF A SIMPLE COGNITIVE TASK. FINAL REPORT

ABSTRACT

The purpose of the study was to determine the usefulness of skin resistance and other physiological measures as indicators of a simple cognitive ability such as the immediate recall of digits. Subjects were placed in a sound attenuated chamber and wired for heart rate and skin resistance recordings. The task involved immediate recall of a 10 alternative digit sequence and a two digit alternative sequence. Results indicated no statistically significant relationship between physiological measures of alertness (skin conductance and heart rate) and a simple cognitive task (digit recall). Further experimentation is required to resolve ambiguity of results; in particular, a design is needed in which task difficulty and task duration are systematically varied over several points over a wide range.

GOVERNMENT RIGHTS IN DATA STATEMENT

Reproduction of this publication in whole or in part is permitted for any purpose of the United States Government.

ED 074774

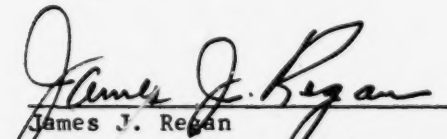
Technical Note: NAVTRAEQUIPCEN TN-8

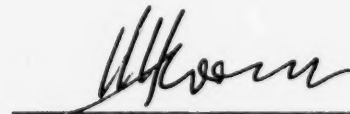
PHYSIOLOGICAL INDICES OF A SIMPLE COGNITIVE TASK

Stephen Jordan
Human Factors Laboratory

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
OFFICE OF EDUCATION
THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL OFFICE OF EDUCATION POSITION OR POLICY.

APPROVED:


James J. Regan
Head, Human Factors Laboratory


Dr. H. H. WOLFF
Technical Director

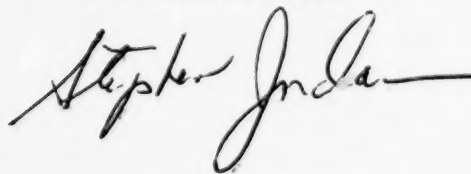
NAVTRAEQUIPCEN TN-8

FOREWORD

The overall objective of Project 7885-23, Levels of Alertness and Military Proficiency, was to investigate the feasibility of enhancing operator performance by providing the operator with a more sensitive and accurate index than he usually gets on his own capacity to perform complex tasks as revealed by physiological measures.

In this experiment the value of heart rate and skin conductance as indices of performance were investigated experimentally.

STEPHEN JORDAN, Ph.D.
Project Psychologist

A handwritten signature in cursive script, reading "Stephen Jordan", followed by a horizontal line.

INTRODUCTION

A positive relationship between the reaction time of a human and the resistance of his skin to the flow of electricity (skin resistance) has been well established by psychophysicologists. The purpose of this study is to determine the usefulness of skin resistance and other physiological measures as indicators of simple cognitive ability, such as the immediate recall of digits. In addition to simplicity, this particular task was chosen for study because it is devoid of any obvious motor component which in itself is known to vary with skin resistance.

EXPERIMENT

Method

Subjects. The 20 subjects (Ss) were paid male volunteers from a local university. Their ages varied from 18-27. Ss with suspected or actual heart or hearing impairments were excluded. Each S was tested for one one-hour session.

Experimental Design

Instructions. The Ss sat in a comfortable recliner in a sound attenuated chamber, and were given the following instructions through an intercom: "Right after I say, ready, I will read a list of numbers which you will repeat to me as soon as I finish reading them. A new list of numbers will be read every 30 seconds. Any questions?"

Procedure

Prior to entry into the sound attenuated chamber each subject was wired for heart rate and skin resistance recordings. Heart signals, which were fed to an Offner A. C. Coupler, type 9806A, were sensed with a pair of Telectrodes filled with Beckman electrode jelly. The Telectrodes were placed at forearm locations. Skin resistance electrodes were clamped to the palm of each hand. These electrodes, which were connected to an Offner Skin Resistance Coupler, Type 9892A, were two cm. diameter zinc plates mounted in plastic cups filled with zinc sulfate paste. After the Ss was comfortably seated in the sound attenuated chamber, and the electrodes were connected to the Offner-type R Dynagraph, the equipment was adjusted to obtain satisfactory readings.

For one-half of the test population the digit recall task began with 60 trials of a 10 alternative digit sequence and ended with 60 trials of a two digit alternative sequence with a five minute rest period between. The order was reversed for the other Ss. In the 10 alternative digit sequence each digit was randomly selected from numbers zero through nine. In the two digit alternative sequence the random selection was from numbers one or two.

NAVTRAEQUIPCEN TN-8

The easier two digit alternative digit recall task was included to determine if task difficulty was a relevant factor. The length of the digit sequence given to the S varied as a function of S's performance. If S correctly repeated a given sequence, it was increased by one digit on the next trial. At the start of each block of 60 trials the digit sequence length was set at three. The rate of presentation of the spoken digits was two per second. A new digit sequence was presented every 30 seconds.

Every effort was made to maintain the Ss in monotonous environment. The inside walls of the soundproofed room were without decoration and aside from the digits spoken by the experimenter and S's response, no other communication was encouraged. The length of each block of trials (30 minutes of uninterrupted testing) was designed to produce fatigue and boredom in the subject, i.e., the aim being to produce sizeable changes in physiological responses and perhaps consequently performance decrement. It was thought that if a relationship between performance and physiological measures existed it would be more readily revealed if changes in physiological response were facilitated by the environmental conditions.

RESULTS

To facilitate statistical analysis the experimental data was grouped into thirds as a function of trials. Analysis of variance was performed using the raw scores from heart rate and digit recall performance and the transformed skin resistance scores. The transformation took the form of

$$\frac{1}{\text{skin resistance in K ohms}} \times 1000 = \text{Microsiemens}$$

A statistically significant decrease in skin conductance ($F = 7.2$, $P = < .01$) as a function of test duration is in evidence for the ten alternative digit recall (see figure 1). There is also a statistically significant ($F = 4.9$, $P = < .05$) lowering of heart rate over time for the ten alternative digital recall (see figure 2). Taken together these physiological measures tend to suggest a decrease in S's level of alertness with time in the test situation. The physiological data for the two alternative digit recall shows the same downward trend in skin conductance (see figure 3) and heart rate (see figure 4) but statistical significance is not achieved for either (an $F = 2.1$, $P = > .05$ for skin conductance and an $F = 2.4$, $P = > .05$ for heart rate).

Contrary to expectation the performance on the digit recall tasks do not fall off with time. The slight downward trend for the 10 digit alternative which is depicted in figure 5 is not statistically significant ($F = .23$, $P = > .05$). In addition, no statistically significant performance decrement ($F = 2.1$, $P = > .05$) occurs over time with the two alternative digit recall (see figure 6). Thus in spite of a marked reduction in subject alertness as measured by heart rate and skin conductance, there is not significant fall-off in the number of digits recalled. It is interesting to note that from a subjective viewpoint the subjects did indeed appear extremely fatigued or bored by the end of the session.

Naval Training Equipment Center, Orlando, Fla.

TR NAVTRAEQUIPCEN TN-8

UNCLASSIFIED
AD

PHYSIOLOGICAL INDICES OF A SIMPLE COGNITIVE
TASK. FINAL REPORT. 1973. 9p., 6 illus.

The purpose of this study was to determine the usefulness of skin resistance and other physiological measures as indicators of simple cognitive ability such as the immediate recall of digits. Subjects were placed in a sound attenuated chamber and wired for heart rate and skin resistance recordings. The tasks consisted of the immediate recall of a 10 alternative digit sequence and a two digit alternative sequence. Results indicated no statistically significant relationship between physiological measures of alertness (skin conductance and heart rate)

KEY WORDS

Physiological psychology
Cognitive ability
Recall tasks
Performance measurements
Alertness

Human Factors Laboratory
Naval Training Equipment
Center, Orlando, Florida

Jordan, Stephen
NAVTRAEQUIPCEN
Task No. 7885-23

Naval Training Equipment Center, Orlando, Fla.

TR NAVTRAEQUIPCEN TN-8

UNCLASSIFIED
AD

PHYSIOLOGICAL INDICES OF A SIMPLE COGNITIVE
TASK. FINAL REPORT. 1973. 9p., 6 illus.

The purpose of this study was to determine the usefulness of skin resistance and other physiological measures as indicators of simple cognitive ability such as the immediate recall of digits. Subjects were placed in a sound attenuated chamber and wired for heart rate and skin resistance recordings. The tasks consisted of the immediate recall of a 10 alternative digit sequence and a two digit alternative sequence. Results indicated no statistically significant relationship between physiological measures of alertness (skin conductance and heart rate)

KEY WORDS

Physiological psychology
Cognitive ability
Recall tasks
Performance measurements
Alertness

Human Factors Laboratory
Naval Training Equipment
Center, Orlando, Florida

Jordan, Stephen
NAVTRAEQUIPCEN
Task No. 7885-23

task duration varied over a wide range.

task duration varied over a wide range.

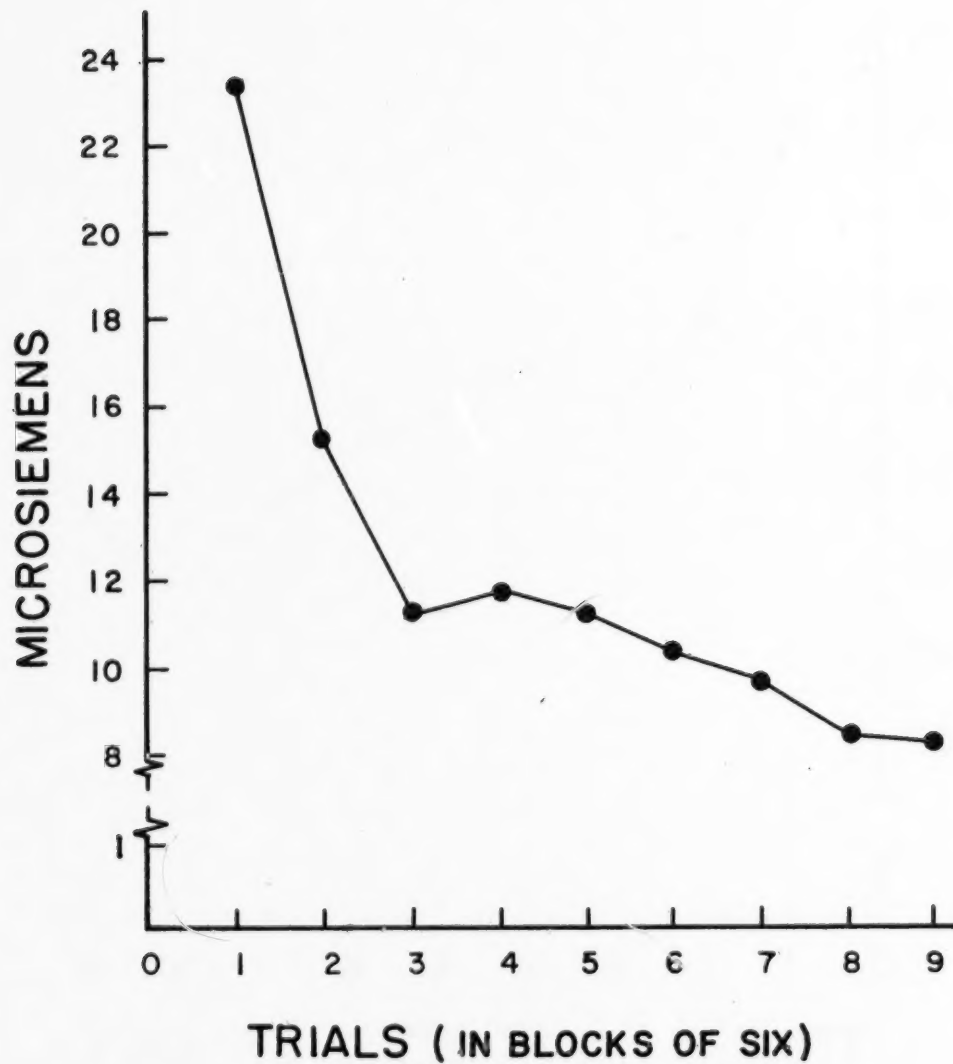


Figure 1. Skin conductance as a function of the number of ten alternative digit recall trials.

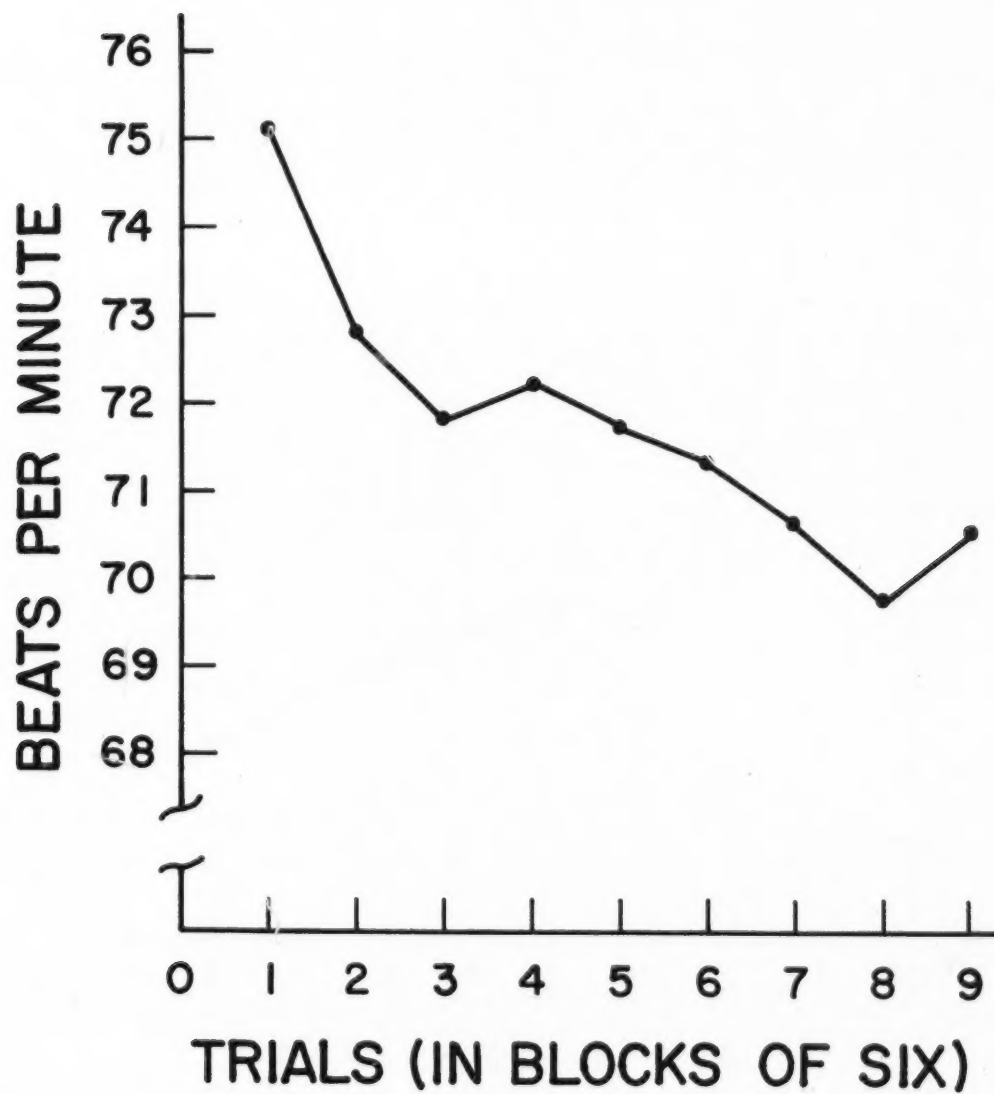


Figure 2. Heart rate as a function of the number of ten alternative digit recall trials.

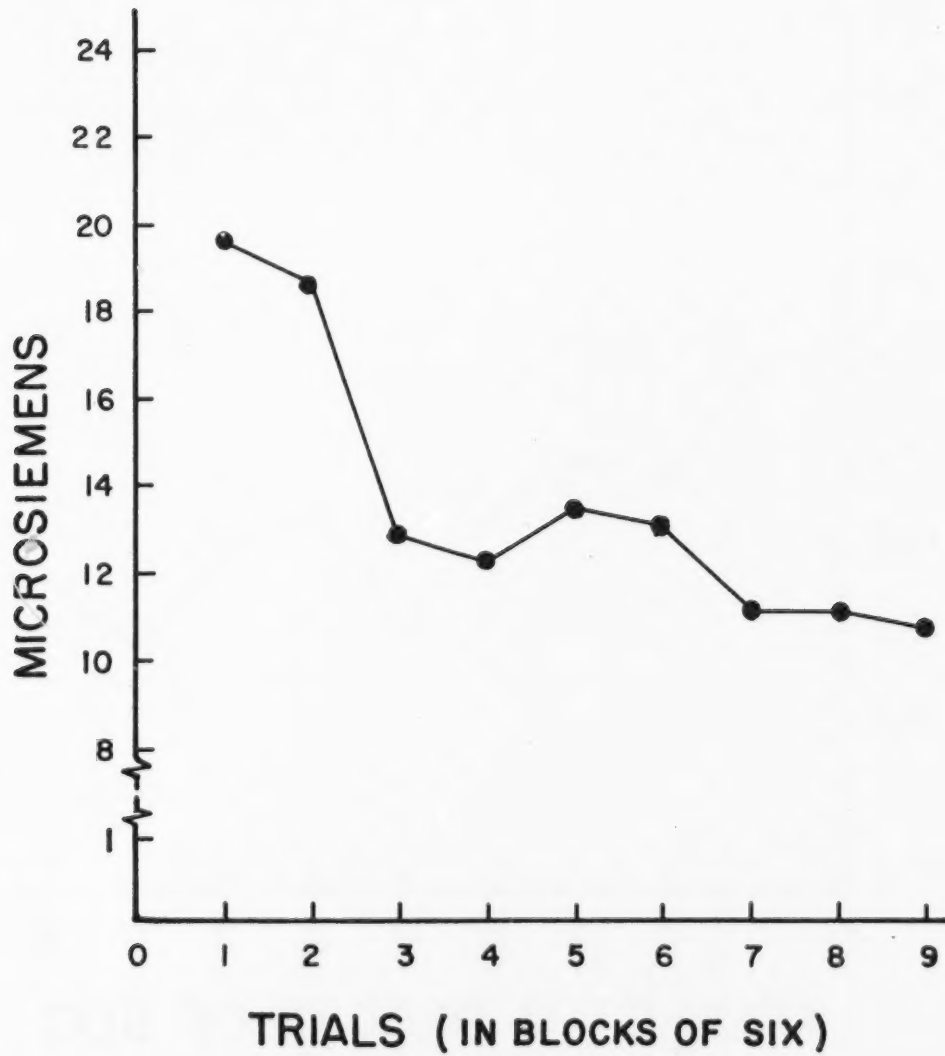


Figure 3. Skin conductance as a function of the number of two alternative digit recall trials.

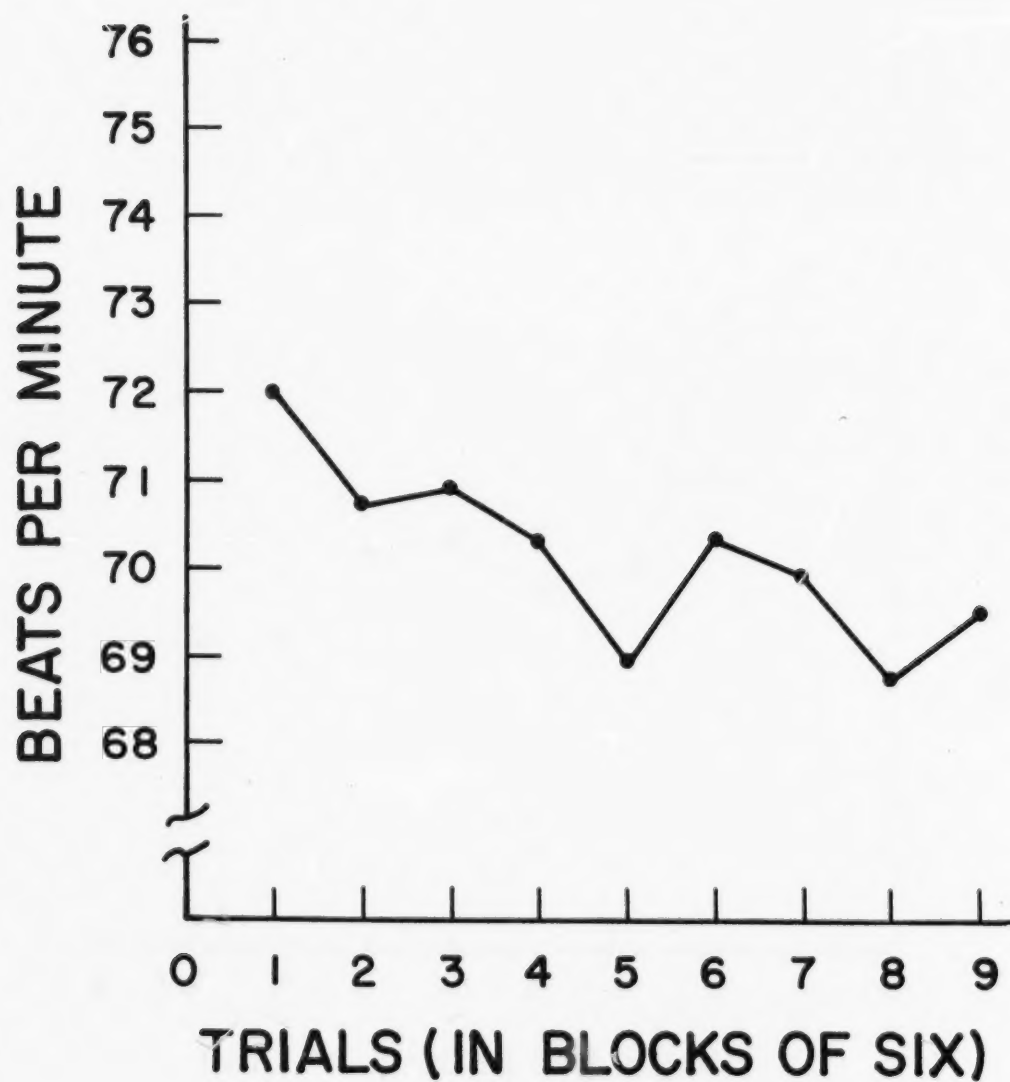


Figure 4. Heart rate as a function of the number of two alternative digit recall trials.

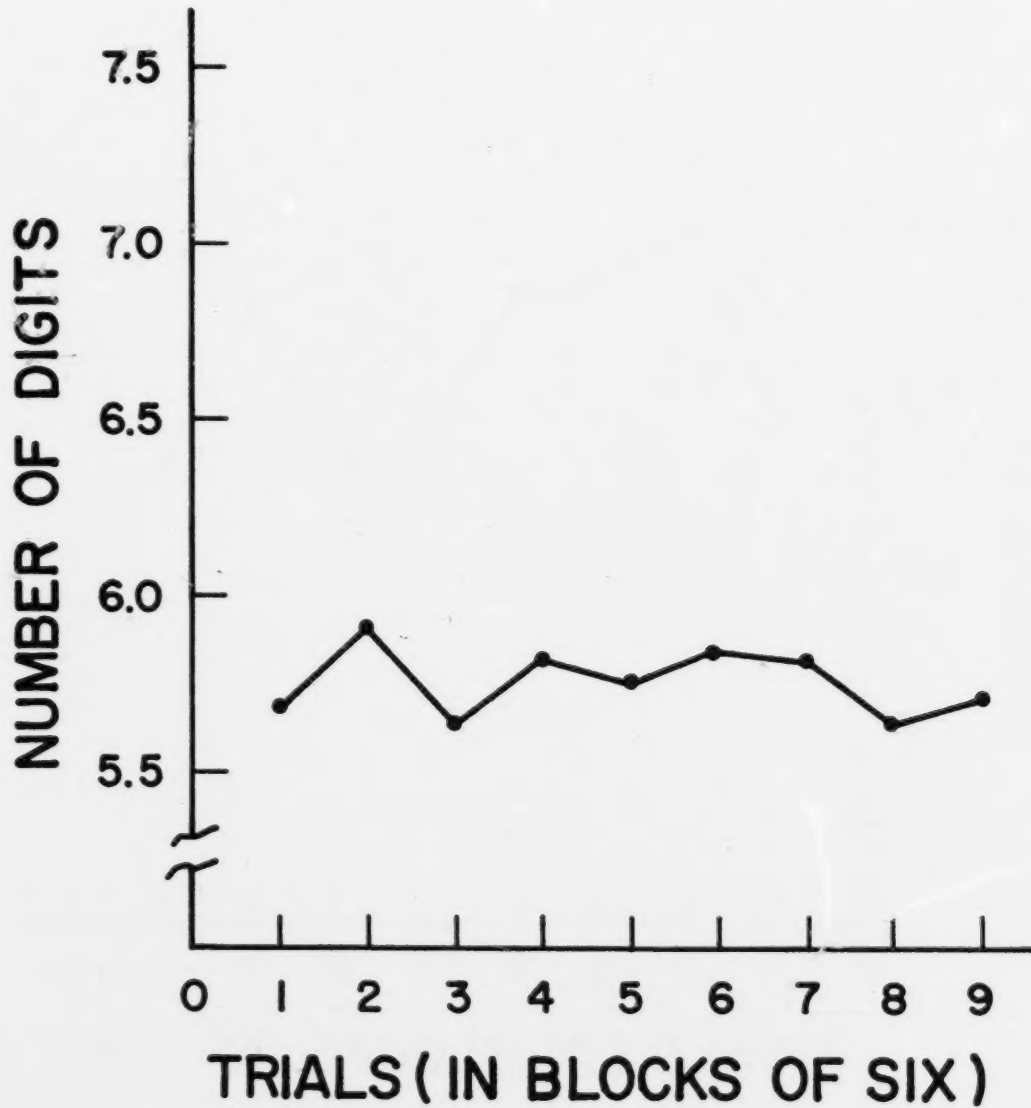


Figure 5. Ten alternative digit recall as a function of the number of trials.

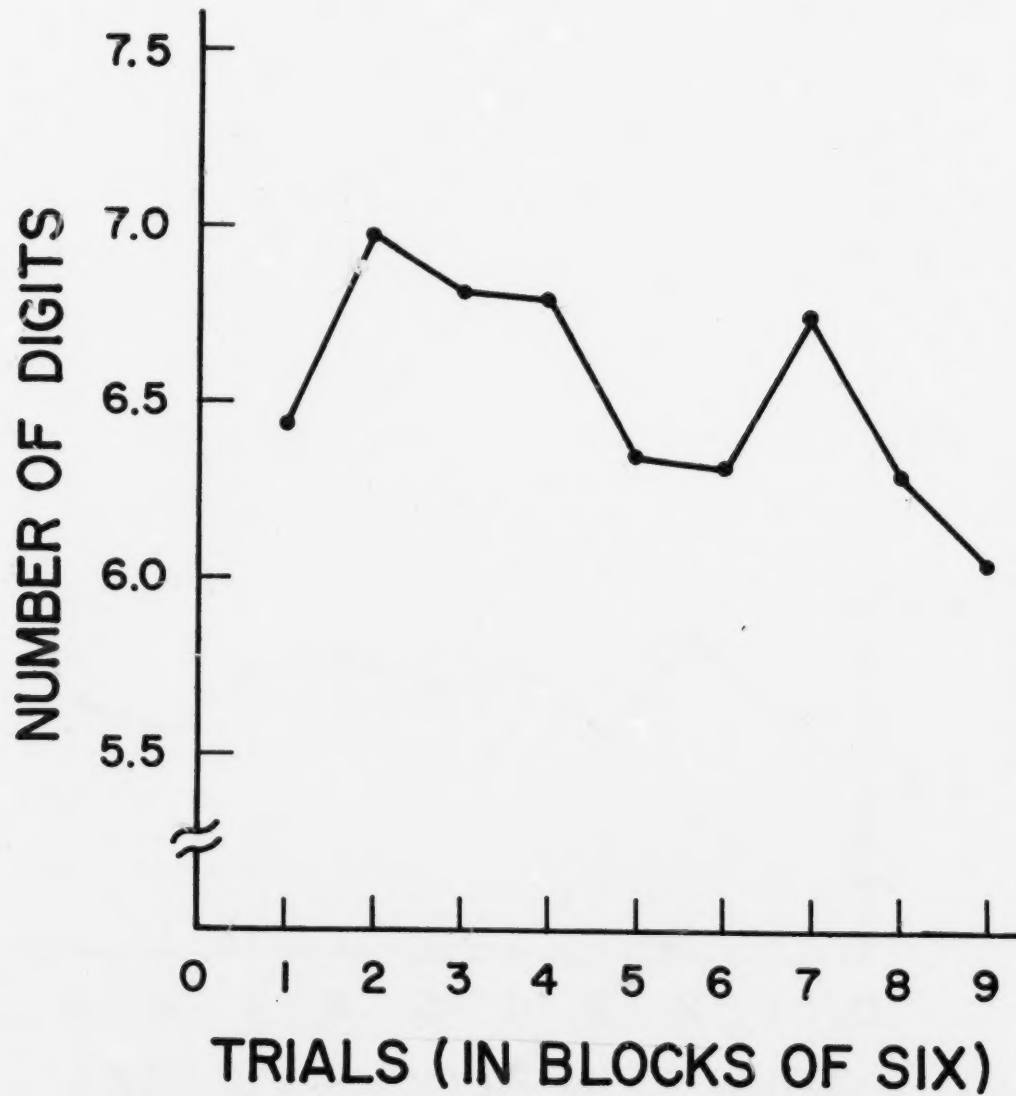


Figure 6. Two alternative digit recall as a function of the number of test trials.

NAVTRAEQUIPCEN TN-8

The absence of a relationship between physiological indices of alertness, i.e., skin conductance and heart rate, and a simple recall task such a digit recall as found in this experiment, does not necessarily mean that they are unrelated. It may be that the Ss were not sufficiently fatigued or bored to fall off in their performance. Perhaps an extreme fatigue state such as is experienced with extended sleep deprivation is required to detrimentally affect the short term store and recall capacity of a human. On the other hand it may be that measures of skin resistance or heart beat are unrelated to the simple cognitive activity under investigation. A third explanation of the result is that simple cognitive functions are unaffected by the level of alertness or awareness of the operation. Wartime stories of radio operators transcribing messages while they were asleep or in a state of semi-consciousness seem to be in line with this interpretation.

Further experimentation is required to resolve the ambiguity which surrounds the present results. In particular, a design is needed in which task difficulty and task duration are systematically varied over several points over a wide range.

SUMMARY

No statistically significant relationship was found between physiological measures of alertness, namely, skin conductance and heart rate, and a simple cognitive task, namely, digit recall.

UNCLASSIFIED

Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) Naval Training Equipment Center Orlando, Florida 32813		2a. REPORT SECURITY CLASSIFICATION Unclassified	
		2b. GROUP	
3. REPORT TITLE PHYSIOLOGICAL INDICES OF A SIMPLE COGNITIVE TASK			
4. DESCRIPTIVE NOTES (Type of report and inclusive dates) Technical Note			
5. AUTHOR(S) (First name, middle initial, last name) Jordan, Stephen			
6. REPORT DATE February 1973		7a. TOTAL NO. OF PAGES 9	7b. NO. OF REFS
8a. CONTRACT OR GRANT NO. In-House		9a. ORIGINATOR'S REPORT NUMBER(S) Technical Note: NAVTRAEQUIPCEN TN-8	
b. PROJECT NO. 7885-23		9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)	
c.			
d.			
10. DISTRIBUTION STATEMENT Approved for public release; distribution is unlimited.			
11. SUPPLEMENTARY NOTES		12. SPONSORING MILITARY ACTIVITY Naval Training Equipment Center Human Factors Laboratory Orlando, Florida 32813	
13. ABSTRACT The purpose of study was to determine the usefulness of skin resistance and other physiological measures as indicators of a simple cognitive ability such as the immediate recall of digits. Subjects were placed in a sound attenuated chamber and wired for heart rate and skin resistance recordings. The task consisted of the immediate recall of a 10 alternative digit sequence and a two digit alternative sequence. Results indicated no statistically significant relationship between physiological measures of alertness (skin conductance and heart rate) and a simple cognitive task (digit recall). Further experimentation is required to resolve ambiguity of results; in particular, a design is needed in which task difficulty and task duration are systematically varied over several points over a wide range.			

UNCLASSIFIED

Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Physiological psychology Cognitive ability Recall tasks Performance measurements Alertness						

UNCLASSIFIED

Security Classification

NAVTRAEQUIPCEN TN-8

HUMAN FACTORS TRAINING DISTRIBUTION LIST

DISTRIBUTION LIST

NOTE

Mailing labels are prepared, when needed, as a computer listing, the source of which is updated on a weekly basis. It is not practical to prepare distribution lists each time labels are prepared. Therefore such lists are prepared semiannually, and a slight discrepancy may exist between the addressees on this list and those appearing on the labels used to distribute this publication.

CHIEF NAVAL RESEARCH ATTN CODE 458 DEPT NAV ARLINGTON VA 22217	1	CHIEF NAVAL MATERIAL MAT 031M WASHINGTON DC 20360	1
COMDT OF MARINE CORPS CODE A03C WASHINGTON DC 20380	1	USAF HUMAN RES LAB PERSONNEL RSCH DIV LACKLAND AFB TX 78236	1
USAF HUMAN RES LAB AFHRL-DO OPERATION OFC BROOKS AFB TX 78235	1	CHIEF OF NAVAL TRNG CODE 017 NAS PENSACOLA FL 32508	1
CDR NAVAIR DEVEL CTR ATTN HUMAN ENGRG BR WARMINISTER PA 18974	1	DIR HUMAN RES RSCH ORG 300 N WASHINGTON ST ALEXANDRIA VA 22314	1
COMMANDER NAVELECSISYSCMD CODE 03 WASHINGTON DC 20360	1	COMMANDER NAVARSYSYSCMD CODE 03 WASHINGTON DC 20360	1
NAVAERSPMEDINST NAVAEROSPREGMEDCEN ATTN CH AVIA PSYCH DIV PENSACOLA FL 32512	1	CDR NAVSHIPS SYS CMD NAVSHIPS SYS CMD HQS SHIPS 03H GEO N GRAINE WASHINGTON DC 20360	1
CHIEF NAVAL OPERATIONS ATTN CDR H J CONNERY MSC OP-701E2 NAVY DEPT WASHINGTON DC 20350	1	CHIEF NAVAL OPERATIONS ATTN DR J J COLLINS OP-07T16 NAVY DEPT WASHINGTON DC 20350	1
CHIEF NAVAL RESEARCH PSYCHOLOGICAL SCIENCES CODE 450 NAVY DEPT ARLINGTON VA 22217	1	ERIC CLEARINGHOUSE UN EDUCAT MEDIA--TECH STANFORD UNIV STANFORD CA 94305	1

NAVTRAEQUIPCEN TN-8

HUMAN FACTORS TRAINING DISTRIBUTION LIST

INSTITUTE OF AVIATION UNIV OF IL URBANA-CHAMPAIGN SAVOY IL 61874	1	CHIEF NAV OPERATIONS ATTN M K MALEHORN OF-14C NAVY DEPT WASHINGTON DC 20350	1
BUREAU NAVAL PERSONNEL ATTN PERS A3 ARLINGTON ANNEX WASHINGTON DC 20370	1	USAF HUMAN RES LAB AFHRL-FT FLYING TRNG DIV WILLIAMS AFB AZ 85224	1
HQS AF SYS CMD DLSL OFC SCIENTIFIC RSCH ANDREWS AFB WASHINGTON DC 20331	1	USAF HUMAN RES LAB AFHRL-TT TECH TRNG DIV LOWRY AFB CO 80230	1
COMMANDER NAVSUPSYSCMD CODE 03 WASHINGTON DC 20360	1	COMMANDER NAVORDSYSCMD CODE 03 WASHINGTON DC 20360	1
COMMANDER NAVSHIPSSYSCMD CODE 03 WASHINGTON DC 20360	1	SCIENTIFIC TECHNICAL INFORMATION OFFICE NASA WASHINGTON DC 20546	1
CH RSCH AND DEVLPMNT CH BEHAVIORAL SCI DIV DEPT OF ARMY WASHINGTON DC 20310	1	BEHAVIORAL SCI DIV OFC CHIEF RSCH - DEVEL DEPT OF ARMY WASHINGTON DC 20310	1
HUMAN RES RSCH ORG DIV NO 1 SYS OPER 300 N WASHINGTON ST ALEXANDRIA VA 22314	1	CHIEF NAV TECH TRNG NAS MEMPHIS 75 ATT CODE 34 DR HARDING MILLINGTON TN 38054	1
HUMAN RESOURCES RESCH ORGZTN DIV 6 AVIATION P O BOX 428 FORT RUCKER AL 36360	1	DR JOHN MEYER HDQTRS AIR TRNG CMD XPT RANDOLPH AFB TX 78148	1
NATL SCIENCE FDN ATTN DR HENRY S ODBERT 1800 G St NW WASHINGTON DC 20550	1	CO NAV MISSILE CTR ATTN HD HUMAN FACTORS ENGRG BR POINT MUGU CA 93042	1

NAVTRAEQUIPCEN TN-8

HUMAN FACTORS TRAINING DISTRIBUTION LIST

COMMANDING OFFICER NAVY MEDICAL NEUROPSYCHIATRIC RESCH UNIT SAN DIEGO CA 92152	1	DEPT OF PSYCHOLOGY UNIV OF IL AT URBANA-CHAMPAIGN PROF PSYCH J A ADAMS CHAMPAIGN IL 61820	1
CO NAVAIR TECH TRNG NAS MEMPHIS ATTN DR G D MAYO HD RESEARCH BR MILLINGTON TN 38054	1	JOSEPH J COWAN CH PERS RSCH BRANCH USCG HQ PO-1 STA 3-12 400 SEVENTH ST S W WASHINGTON DC 20590	1
DIR DEF RSCH - ENGRG ARPA BEHAVIORAL SCI DIV ATTN LCOL A W KIBLER WASHINGTON DC 20301	1	DIRECTOR USA MOTIVATION-TRA LAB COMMONWEALTH BLDG 1300 WILSON BLVD ARLINGTON VA 22209	1
USAF HUMAN RES LAB AFHRL-TR TRNG RES DIV WRIGHT-PATTERSON AFB OH. 45433	1	EXECUTIVE EDITOR PSYCHO ABSTRACTS AMERICAN PSYCH ASSOC 1200 17TH ST NN WASHINGTON DC 20036	1
COMMANDER NAVFAC ENGR CMD NAVFAC ENGR CMD HDQ ASST DIR R D DIV CODE 03 WASHINGTON DC 20390	1	DR RALPH R CANTER DIR MIL MANPWR RSCH OASD M-RA MR-U PENTAGON RM 3D960 WASHINGTON DC 20301	1
US ARMY BEHAVIORAL SCI RESEARCH LAB COMMONWEALTH BLDG RM 239 1320 WILSON BLVD ARLINGTON VA 22209	1	DR. JOHN W WEISZ DIR HUMAN ENGRG LAB USA ABERDEEN RSCH DEVEL CTR ABERDEEN PROV GROUNDS MD 21005	1
COMMANDING OFFICER PERS-TRNG RSCH DEV LAB SAN DIEGO CA 92152		NAV PERSONNEL RSCH AND DEVELOPMENT LABORATORY ATTN LIBRARY BLDG 200 RM 3307 WNY WASHINGTON DC 20390	1
CO NAVMED RSCH INST NATL NAVMED CTR ATTN TECH REF LIB BETHESDA MD 20014 Commanding Officer Naval Training Equipment Center Orlando, Florida 32813	1 43	CH NAVTRASUP CODE N-2, BLDG 45 (DR CHARLES HAVENS) NAS PENSACOLA FL 32508	
		Defense Documentation Center Cameron Station Alexandria, Virginia 22314	12